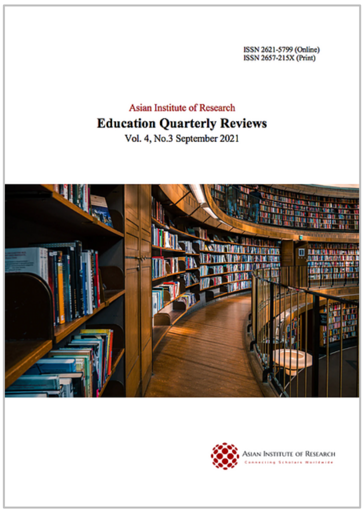


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# The Effect of Contextual Teaching and Learning (CTL) Model With Outdoor Approach Towards the Students' Ability of Mathematical Representation

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**Abstract**
This study aimed to determine the effect of the implementation of the Contextual Teaching and Learning (CTL) model with the outdoor approach towards students' ability in mathematical representation. It was quasi-experimental research consisting of two experimental classes and one control group. It used a pretest-posttest control group design. The population of this study was the students of SUPM Tegal. Sampling was conducted using cluster random consisting of three classes. The first experimental group was carried out by implementing the learning model of CTL with the outdoor approach. The second experimental group was carried out by implementing a learning model of CTL, while the control group was conducted by implementing a conventional learning model. The research instrument was a 7-point mathematical representation test in the form of an essay. The results of the research were 1) the learning model of CTL with an outdoor approach affected the improvement and achievement of the students' ability in mathematical representation and was higher than CTL and a conventional learning; 2) the improvement of the students' ability of representation in the groups of CTL with outdoor approach, CTL, and conventional learning respectively was in high, medium, and low category.

**Keywords:** Contextual Teaching-Learning, Outdoor, Mathematical Representation

## 1. Introduction

There are five standards of mathematical abilities achieved by students in the implementation of mathematics in schools, including communication, problem-solving, reasoning, connection and representation (NCTM, 2000). Representation is used as a tool to support reflection and to communicate mathematical ideas in the form of symbols, pictures, words, sentences, and tables (Anastasiadou, 2008; Goldin, 2002). According to Yuniawatika (2011), the ability of mathematical representation is one of the process skills related to students' ability in submitting reports and ideas. In addition, representation plays an important role in solving mathematical problems, especially difficult or verbal tests. This is because problem-solvers often externalize verbal expressions in situations using symbols or visuals (Ulusoy & Argun, 2017; Yee & Bostic, 2014). In addition, students access mathematics through representations. In this regard, representational thinking of serving as a central disciplinary practice as well as a learning practice supports further study of the discipline (Selling, 2016). Representation may be a particularly generative learning practice for students who were previously not successful in school.

Generally, in Indonesia, students' ability in mathematics is not fully optimized. This was confirmed in the research from the Program for International Student Assessment (PISA) (OECD, 2014) which showed Indonesia students ranked 64th out of 65 countries with a score of 397. In addition, the result of Trends in International Mathematical and Science Study (TIMSS) in 2015, recently published in December 2016, showed Indonesia ranked 46th out of 51 countries with a score of 397. This was supported with the data from the Mathematics test at the odd semester year 2017/2018 in this research population. For instance, in class X more than 70% of the students had the scores under Minimum Mastery Criteria (MMC). From the analysis, students performed poorly on algebraic equations, relations & functions, and geometry. The causative factors included: 1) challenge in interpreting the problem or information, 2) difficulty in presenting the data or information in tables, pictures, or charts, 3) difficulties in solving the mathematical problems due cramming of the steps examples given and exercises, and 4) difficulty in creating and answer questions using words or written texts. Evidently, there was a need for improvement. The main and fundamental difficulty experienced by students, especially elementary school students is to represent their mathematical ideas in the form of appropriate symbols (Yumiati & Haji, 2018). This shows that students' mathematical representation ability is a crucial problem and needs to be optimized. This is what motivates the author to improve the students' mathematical representation skills through the application of CTL learning which is carried out in an outdoor class.

According to Kartini (2009), students perform poorly because of cramming the steps given by their teachers and are deprived of the chance to show their own working. Besides, Trianto (2007) was of the opinion that classroom learning is teacher-centered and makes students passive. The students are not provided with relevant models which facilitate learning and thinking objectively about mathematical problems. According to the observations and interviews on teachers, the learning model was conventional. The process used teacher-centered and used monotonous steps, where the concept was explained, an example for illustration, and exercises are given. Meanwhile, students' representational abilities can develop if students are given broad opportunities to express their mathematical ideas through student-centered learning. This is a gap between the demands of student activities to be creative with learning that does not give students the freedom to be creative (teacher-centered). The contextual teaching and learning (CTL) model might be a better alternative for improving students' abilities (Hoogland, de Koning, Bakker, Pepin, & Gravemeijer, 2018; Rustam & Handayani, 2017; Rustam & Adili, 2016). Mathematical abilities, including representation, develop through learning from the context (Clarke & Roche, 2018; Mamolo, 2018).

Jaenudin (2008) stated that in the contextual approach, the students are given chances to construct the learned mathematical concept through an inquiry process. In this case, if they construct and find solutions, and representation ability increases. This could be on various aspects such as visual and words or written texts. During the inquiry process, students learn with the groups expected to have knowledge sharing. Besides, learners see the available model, whether it is given by the teacher or available in the environment. While in the learning community, there will be asking for activities. At that moment, the students who have better representation ability help others.

The purpose of this study, therefore, was to critically analyze the CTL combined outdoor approach to learning. Generally, outdoor learning is conducted outside the classroom with the aim of exposing students to the real world (Husamah, 2013). Moreover, it is an activity that improves children's physical and skill development based on their individual abilities; areas of observation, exploration, and adventure contributing to their cognitive development; and the things increasing their creative aptitude. In addition, outdoor learning facilitates areas supporting social developments and provides the opportunity for students to be with other people in the community. By so doing, learners might obtain relevant information on living things, life cycles and environmental conditions (Acar, 2014; Spalie, Utaberta, Abdullah, Tahir, & Che, 2011; Sumpter & Hedefalk, 2015). This study examined the effect of the model learning strategy of Contextual Teaching and Learning (CTL) with the outdoor approach on students' ability in mathematical representations. The strategy emphasized on the implementation of mathematics learning linked to practical situations.

The scientific novelties of this research are: a) The CTL model is used with an outdoor learning approach, so that the meaning of context in CTL is more meaningful because the context is more concrete, in accordance with everyday life; b) The mathematical concept developed through the learning model is closely related to everyday life, namely a two-variable linear equation system.

### *1.1. The ability of mathematical representation*

From the Great Dictionary of the Indonesian Language (KBBI, 2002), representation refers to the depiction of an object. According to Alhadad (2010), it is an expression of mathematical ideas presented by students as a model from a problem situation used to find the solution through mind interpretation. According to (Effendi (2012), mathematical representation ability is needed for students to find and create a tool for communicating the abstract and concrete mathematical ideas in order to be understood. The indicators of mathematical ability used in this research included: a visual representation (diagrams, tables or charts, and pictures), equation or mathematical expression, and words or written texts.

### *1.2. The theory of constructivism learning*

Constructivism refers to a philosophy in educational psychology which emphasizes that knowledge is a formation/construction. According to Poedjiadi (2005), this theory starts with formation and knowledge reconstruction. It means changing someone's knowledge previously formed or constructed as a result of the interaction with the environment. From Suwarna (2016), constructivism is the foundation of thinking of contextual learning. This means learning is built step by step and the results are expanded through limited contexts and not a sudden process. It is the refinement of the traditional approach to learning, mostly based on behaviourism.

### *1.3. The learning model of contextual teaching and learning (CTL)*

Contextual learning is a system based on the philosophy and means students have the ability to understand if they get the meaning of the academic materials and understand assignments given. Furthermore, it is important to associate the new information with knowledge and experiences learned before (Johnson, 2007). According to Trianto (2009), contextual learning is a concept which helps teachers to associate the subject contents with the situation in the real world and motivate students to make a connection between knowledge and implementation in their life. Based on the Department of National Education (Depdiknas, 2003), there are 7 main components of contextual learning, including 1) constructivism, 2) interdependent learning groups, 3) inquiry, 4) questioning, 5) modeling, 6) reflection, and 7) authentic assessment.

### *1.4. Outdoor study*

According to Widiasworo (2017), the outdoor study includes an outside activity taking place in the field or away from the classroom. It is perceived as a subject area and a learning strategy. For this reason, it requires content, in the same way as other subject areas and should be enrolled and taught by experienced teachers. If perceived as a methodology or a context and approach to learning rather than a discipline, attention should be on the process, pedagogy, and approaches to outdoor learning used across a range of learning areas (Dyment et al., 2018). Rickinson, M., Dillon, J., Teamey, K., Morris, M., Choi, M. Y., Sanders, D., & Benefield (2004) described three types of outdoor learning, a) fieldwork and outdoor visits, b) outdoor adventure education, and 3) school ground/community projects. This article views outdoor learning as a strategy. The focus is most closely related to fieldwork and outdoor visits, where learning activities are linked with a particular curriculum in outdoor settings.

Outdoor learning involves activities outside the classroom and it is especially effective in fostering key non-cognitive factors (Richmond et al., 2017). This study examined the effect of outdoor learning on cognitive factors. In general, outdoor learning is defined as purposeful and planned erudition experiences outside (Romar, Enqvist, Kulmala, Kallio, & Tammelin, 2018). According to Sumarmi (2012), it is one of the learning techniques which emphasize on the activities, skills developments, and students' knowledge through direct observation of the real objects. In addition, Stevens & Scott (Haji & Maizora, 2015) stated that children learning outside the school have more chances of understanding various mathematical objects related to the surrounding environment.

### *1.5. Model of contextual teaching and learning (CTL) with outdoor approach*

The Contextual Teaching and Learning (CTL) with the outdoor approach is defined as the learning process conducted by associating mathematical learning materials with the implementation of the students' daily life and activities outside the classroom. The learning steps using this approach involves the teacher prepares the students, conveying the learning objectives, pass apperception, delivering the material topic learned and the procedures of the learning the model used, dividing the students into some groups, taking them outside the classroom to places related to mathematical material, learners observing and manipulating objects, teachers guiding discussions on various mathematical concepts in the objects outside the classroom, concluding learning, understanding reflection, and instructors giving assignments to students in order to strengthen their understanding of the concept learned and convey the material to be considered in the next class meeting.

## 2. Method

This was an experimental quasi study using "pretest-posttest control design." The design is described as follows (Table 1.).

Table 1: Research Design

| **Group** | ***Pre-test*** | ***Treatment*** | ***Post-test*** |
|---|---|---|---|
| Experimental 1 | $Y_1$ | $X_1$ | $Y_2$ |
| Experimental 2 | $Y_1$ | $X_2$ | $Y_2$ |
| Control | $Y_1$ | 0 | $Y_2$ |

*Notes:*
*X1 : The learning model of CTL with outdoor approach*
*X2 : The learning of CTL*
*Y1 : Pre-test*
*Y2 : Post-test*

The research population included students of class X from State High School of Fisheries Enterprise (SUPMN) Tegal equivalent to Vocational High School (VHS). This class consisted of four major sets including Nautical Marine Fisheries (NMF), Teknika Marine Fisheries (TMF), Aquaculture Technology (AT) and Fisheries Product Processing Technology (FPPT), each with two classrooms. The students were equally distributed without considering such things as superior or non-superior classes. Based on the test results of class X SUPMN Tegal at the odd semester, the average of Mathematics scores of eight classrooms was relatively the same, ranging from 55.4 to 58.7. The sample of three classrooms was chosen using cluster random sampling as shown in Table 2

Table 2: Research Sample

| Group | Learning | Class | Number of Students |
|---|---|---|---|
| Experimental 1 | CTL with outdoor approach | X *AT*-B | 15 |
| Experimental 2 | CTL | X *AT-A* | 15 |
| Control | Conventional | X *TMF*-A | 15 |

A test of mathematical representation ability consisting of seven items in form of an essay that was valid, reliable and with a good level of difficulty and discrimination power based on the results of the trial was used. The data were both quantitative and qualitative. Specifically, the qualitative data were descriptive, consisting of the results of the pre-test, post-test, and N-gain. The N-gain is a normalized gain calculated using the formula:

$$\text{N-Gain } (g) = \frac{\text{post-test score - pre-test score}}{\text{ideal maximum score - pre-test score}}$$

Then, the data of N-gain were grouped with interpretation criteria from Hake (1999) as follows (Table 3.).

Table 3: N-gain Criteria

| **N-gain Criteria** | **N-gain Interval** |
|---|---|
| High | N-gain > 0,7 |
| Medium | 0,3 < N-gain ≤ 0,7 |
| Low | N-gain ≤ 0,3 |

The quantitative data were analyzed using the following four steps 1) Normality test; 2) Homogeneity test; 3) Hypothesis test using F test or one way ANOVA; and 4) Advanced test to find out the learning model with significant improvement difference using the analysis of Post Hoc Test.

**3. Result and discussion**

A linear program was used in this study as learning material. The students were able to 1) determine the solution set of linear inequalities system of two variables by drawing graphs; 2) translate story items (verbal words) into sentences; 3) establish the solution set of mathematical sentences; 4) find the objective function of items; and 5) determine the optimal value based on the objective function using the corner point method. The indicators showed the linear program could be used as means of gaining and finding out the ability of mathematical representation, visual depictions (graphs or tables), mathematical equations and expressions, and words or written texts. The teacher should interpret students ideas in solving story items related to a linear program. Additionally, the material could be essential in the students' daily life. The students thought the material would be useful during their internship. For example, it was necessary to determine how much-processed fish is needed to get maximum sales results. Using the knowledge of linear programming, the problem could be solved effectively.

The objective of this research was to find out the effect of CTL with outdoor learning approach on students' representation ability. To measure the objective, a test of mathematical representation ability was given before and after the learning process. The data obtained was as shown in Figure 1.

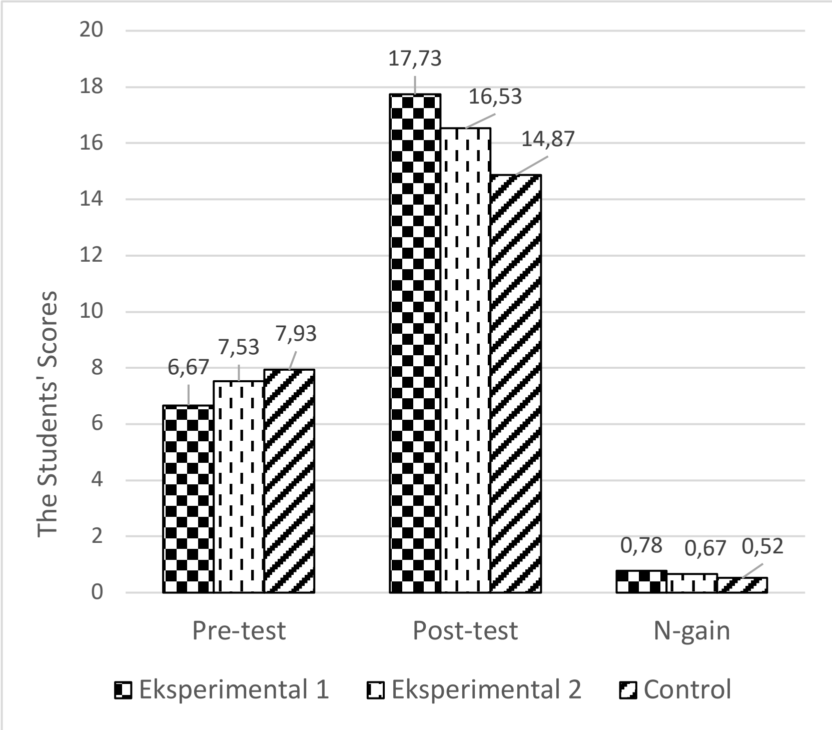


Figure 1: The scores of Pre-Test, Post-test, and N-Gain

*Note: ideal score = 21*

Based on Figure 1, the pre-test score of the students' mathematical representation ability at the control group was higher than the experimental class 1 and 2. Furthermore, the post-test score (achievement) at the experimental class 1 was higher than the class 2 and the control one. Besides, N-gain (improvement) of the students' ability of mathematical representation at the experimental class 1 was higher than in both 2 and control classes. Based on N-gain criteria of Hake (1999), the improvement of the students' mathematical representation ability at the experimental class 1 was at the high category while experimental class 2 and control group were at the medium category. In descriptive, the CTL learning with outdoor approach affected more the achievement and improvement of the students' ability than the CTL and conventional approaches.

To find out whether the effect was significant, statistical a test was carried out. Based on normality and homogeneity tests of the three groups of class, the data of the pre-test and the post-test scores, and N-gain of the mathematical representation ability were distributed in s normal and homogeneous way. The test result of one way ANOVA showed the students' pre-test scores of the three learning groups were not significantly different. This indicated the students' initial ability of representation in the three learning groups was relatively the same. If there was a difference at the end of learning, it was caused by the model used. The test result of one way ANOVA on the learning effect was as shown in Table 4.

Table 4: The Result of Significance Test of the Average Difference of Post-Test and N-Gain Scores

| **Data** | | **Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
|---|---|---|---|---|---|---|
| Post-test | Between Groups | 62.178 | 2 | 31.089 | 10.845 | .000 |
| | Within Groups | 120.400 | 42 | 2.867 | | |
| | Total | 182.578 | 44 | | | |
| N-gain | Between Groups | .512 | 2 | .256 | 16.878 | .000 |
| | Within Groups | .637 | 42 | .015 | | |

| **Data** | | **Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
|---|---|---|---|---|---|---|
| Post-test | Between Groups | 62.178 | 2 | 31.089 | 10.845 | .000 |
| | Within Groups | 120.400 | 42 | 2.867 | | |
| | Total | 1.149 | 44 | | | |

The result of statistical test count significance level (sig.) = 0.000 < significance level (α) = 0.05. This shows there was a difference between achievement (post-test) and improvement (N-gain) of the students' ability in using the CTL model with outdoor approach, CTL, and conventional learning. To find out the one with a more significant improvement, an advanced test was carried out. This was the Post Hoc Test analysis using Scheffe test. The result were as shown in the Table 5.

Table 5: Scheffe Test Results

| Data | (I) Class | (J) Class | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| Post-test | Experimental 1 | Experimental 2 | 1.200 | .618 | .165 | -.37 | 2.77 |
| | | Control | 2.867* | .618 | .000 | 1.30 | 4.44 |
| | Experimental 2 | Control | 1.667* | .618 | .035 | .10 | 3.24 |
| N-Gain | Experimental 1 | Experimental 2 | .26667* | .03510 | .000 | .1776 | .3557 |
| | | Control | .66200* | .03510 | .000 | .5729 | .7511 |
| | Experimental 2 | Control | .39533* | .03510 | .000 | .3063 | .4844 |

The average difference of the achievement and improvement of the students' ability at each classroom shown in the column of Mean Difference (I-J) of output SPSS was positive. The highest greatest differences in the achievement and improvement of the mathematical representation ability between the CTL classroom with an outdoor approach and conventional classroom are at 2.867 and 0.66200 respectively. The second highest greatest difference in the average achievement and improvements were between the CTL and conventional classrooms consisting of 1.667 and 0.39533 respectively. Moreover, the average differences between the CTL classroom with an outdoor approach and CTL classroom were at 1.200 and 0.26667 respectively (See Table 5.). The conclusions of the result of Post Hoc Test were as follows 1) the achievement and improvement of the students' mathematical representation at the CTL classroom with the outdoor approach is higher than at the CTL and conventional classrooms, and 2) the achievement and improvement of the students' mathematical representation at the CTL classroom is higher than at the conventional classroom.

In this study, the CTL with outdoor approach affected the students' ability, showing better improvement than the CTL and conventional learning. The improvement of the mathematical representation ability of the learning model of CTL with outdoor approach was 0.78 (the high category). This was higher than the CTL (0.67, the medium category) and conventional learning (0.52, the medium category). See Fig. 1. Additionally, the CTL activities with outdoor approach could develop and improve the students' abilities. This could happen because the natural learning process was related to the real life and gave students chances to be active in learning, constructing, discussing, finding out, and solving the real problem outside the classroom. According to McCoy, Baker, & Little (1996), mathematics learning involving students in practicing and communicating through a variety of representations leads to a richer learning environment. This is in line with the concept of Bruner (Muchith, 2007) which stated that the learning process is influenced by the dynamics of reality development around students. The implication here is that the learning process might be effective and efficient if teachers give chances to students to find out concepts, theories, rules, or experiences through the examples encountered in life.

Besides, learning is not only conducted normatively or textually but also contextually. According to McCoy et al. (1996), mathematics learning activities involving students in practicing and communicating using a variety of representations enrich the learning environment.

Suwanjal (2016) supports the findings related to CTL learning with outdoor research. It showed the implementation of contextual approach could improve the critical thinking ability among students of Junior High School. According to Indahsari (2015), the performance of students of Junior High School with learning activities outside the classroom was higher than the results obtained in the classroom learning. Nevertheless, these results are not in line with Otte, Bølling, Elsborg, Nielsen, & Bentsen (2019). From their explorative study, teaching outside the classroom neither harmed nor improved pupils' mathematical skills.

## 4. Conclusion

This study examined the impact of CTL model with an outdoor approach on the mathematical representation ability. Three classes were used as research samples. The first Class 1 applied CTL with outdoor approach (exp eriment 1), the second class 2 the CTL (experiment 2), and 3 the conventional learning (control). The improvement of the students' mathematical representation ability using the learning model of CTL with outdoor approach was higher than the CTL and conventional learning. The improvement in the learning model of CTL with outdoor approach was also higher than the CTL and conventional learning.

The CTL learning with outdoor approach could develop and improve the students' mathematical representation ability significantly. Moreover, CTL learning with the outdoor approach is a natural process related to real life and keeps students active in constructing, discussing, finding out, and solving the real problem outside the classroom. Further research is needed to investigate the broader influence of CTL with the outdoor approach. For example, there is a need to recognize the influence of the difference between students with high, medium, and low mathematical abilities.

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